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LUMINARY Memo #167

To: Distribution
From: B. McCoy, P. Rye
Date: 17 August 1970
Subject: Luminary 1D: Which One, What Kind, How Many?

Luminary 1D will be released for the third time on 19 September 1970; its revision # is 178. The new changes incorporated are PCRs 322, 1056 and 1058. Herewith are the descriptions.

PCR 322: One of the major causes of the predatory "throttle castellations" was the response time of the DPS throttle (THROTLAG). The previous value was 0.2 seconds; the new value is 0.08 seconds.

PCR 1056: The required ullage time for a very light Ascent Stage burn using 2 jets is 14 seconds before ignition. The previous Luminary 1D had assumed 3.5 seconds of ullage before ignition causing 2-3 fps overburn. The Apollo 14 crew will be using 4 jet ullage and this would contribute another 2-3 fps to the overburn. Luminary 178 will turn on ullage at 6 seconds prior to ignition. For 4 jet ullage, the required ullage time is 30 seconds. Since, the LGC turns it on at TIG -6 seconds, the astronaut can release the ACA when V99 appears (at TIG -5 seconds). Specifically, "P42TABLE +6" was changed to 2390 (-29.9 +6 seconds) and S40.13 uses "FRCS4" instead of "FRCS2" to assume 4 jet ullage, and also it uses "6.5 SECS" to assume 6.5 seconds of ullage (ullage is turned off at TIG +0.5 seconds). The value of K1VAL (total APS impulse in one second) was 2800 lbf· sec which is based on a "dry" (not yet fired) APS engine. The TPI impulsive burn and most conceivable burns on the APS (except lunar ascent) will be done on a "wet" engine. The value of 2800 lb/sec caused an overburn of roughly 2 fps. This value was changed to 3150 lbf· sec (extrapolation of data from LM Data Book).

PCR 1058: When it was found that the Landing Analog Displays Routine (R10) gave results with errors up to 3.5 fps in the cross pointer display, a new R10 was suggested to effectively eliminate these errors. In the process the altitude-rate glitch was eliminated. The word saving was 119 words; the new R10 takes 1% longer. The main cause of the errors was the single precision dot products; these were changed to double precision. Also, some computational simplifications were made to the dot products, knowing that the IMU is aligned to the landing site. A PIPA bias correction term is added to increase accuracy; computation of VBIAS formerly done in P66 is now done in SERVICER. Altitude is based on a simpler extrapolation than before. R10 now computes altitude and Alt-Rate every pass (every 1/4 second) outputting Alt-Rate before a 12 cs pause, Altitude immediately after the pause. Flag bit SWANDISP is now set immediately after SERVICER computes the parameters necessary for R10 so that R10 may start near TIG -30 rather than at ignition. The DIDFLAG definition remains the same; just DID the initialization. IMODES33 bit 7 is no longer used.

ACB L-11 and Anomaly L-1B-04 were not incorporated into the new R10 as originally conceived, but they are in Luminary 178: The forward velocity for NOUN 60 will be computed if the MODE SELECT switch is not in PGNCS (and incidentally accurate to 0.1 fps); R10 will be initialized if the RR CDU ENABLE bit is removed by e.g. moving the RR MODE switch into and out of LGC.

The R10FLAG has been redefined. When it's set by P12, P70, P71, the inertial Y velocity will be displayed on the lateral velocity cross pointer while the forward velocity crosspointer is set to be zero. The lateral velocity is VVECT +2 minus VSURFACE +2;(inertial (Y)- SURFACE (Y) velocities).

Flow Charts for R10 and its interface parameter computation are attached. For more details see Luminary Memo #162 by Don Eyles. This memo superceeds Memo #162 where differences occur.

Changes to other areas due to R10 design:

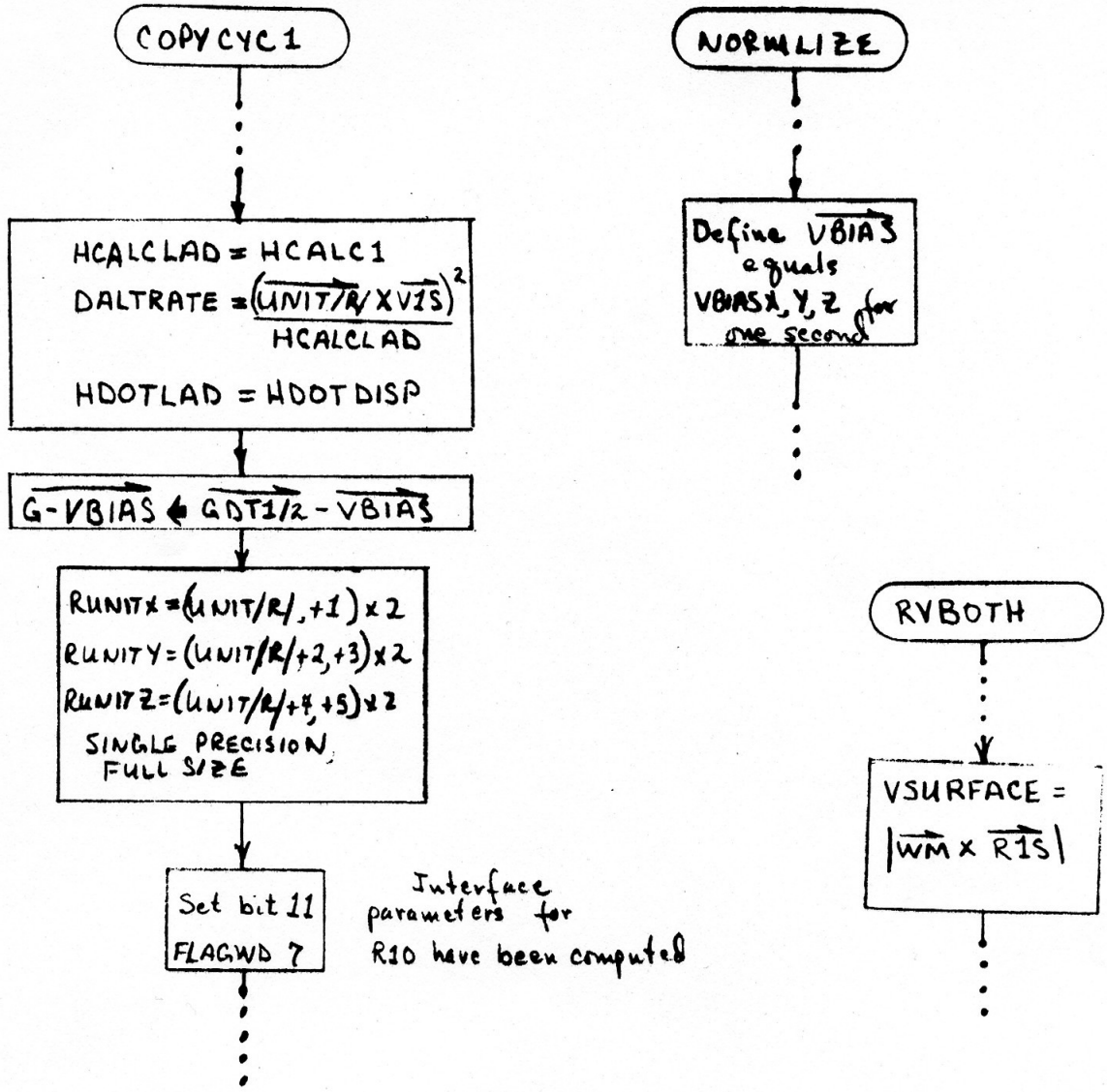
1. downlist neumonic changes

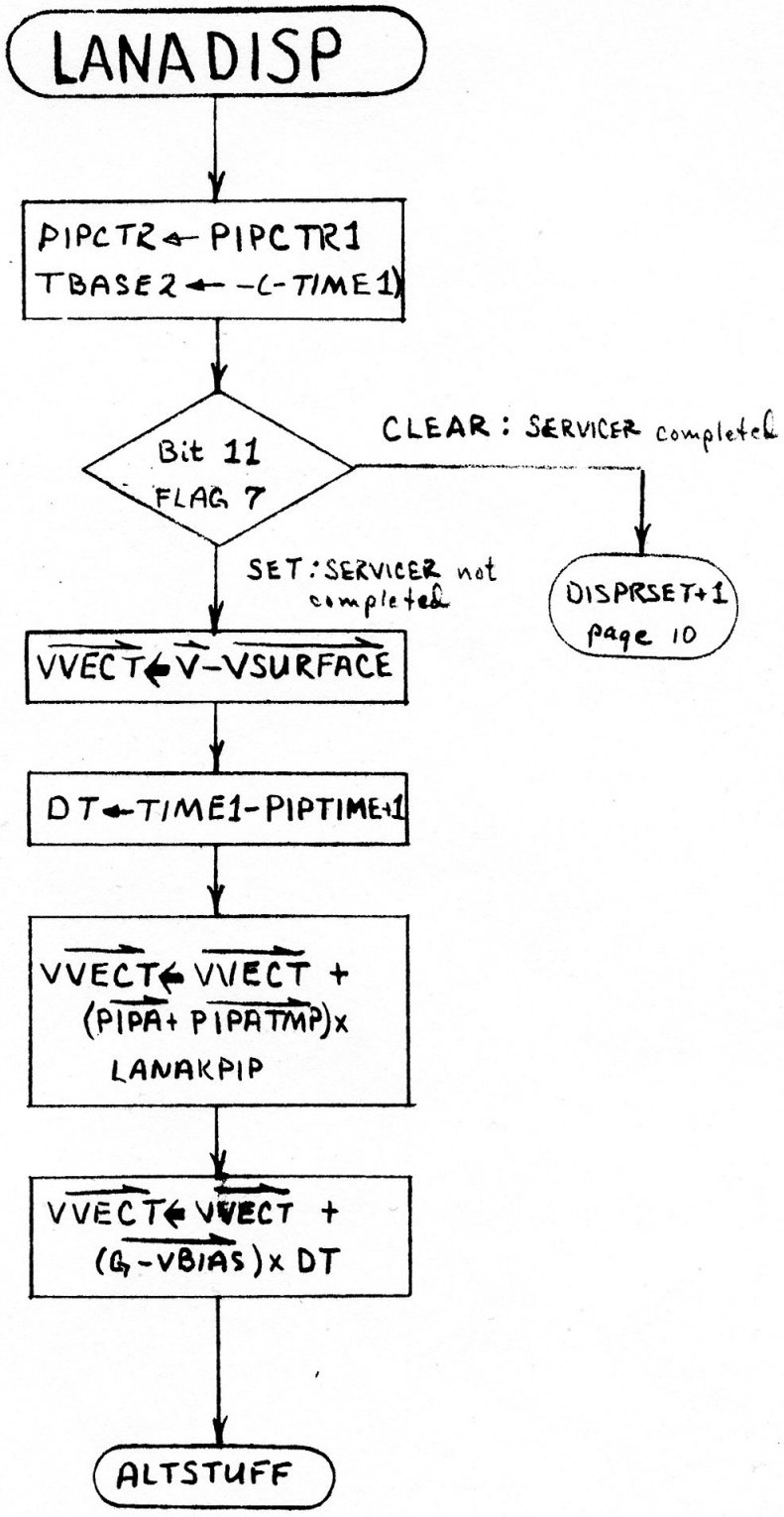
   LATVEL to LATVMETR

   FORVEL to FORVMETR

2. VBIAS calculation moved from STRTP66A into NORMLZE; parameter GHZ removed
3. For erasable overlay purposes ZAXIS computation moved to Ascent Guidance from P12 initialization.

R10 COMPUTATIONS in SERVICER





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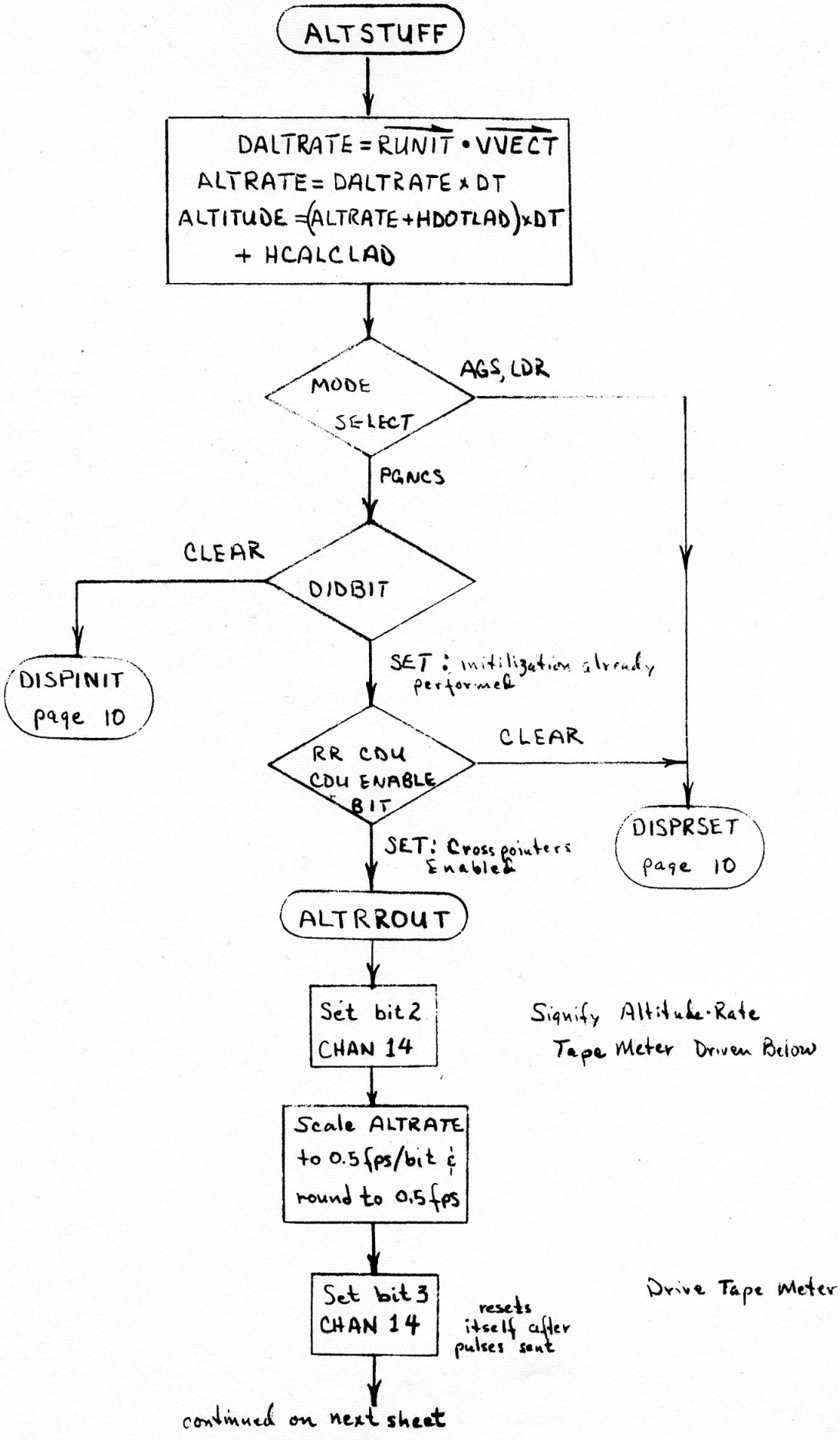
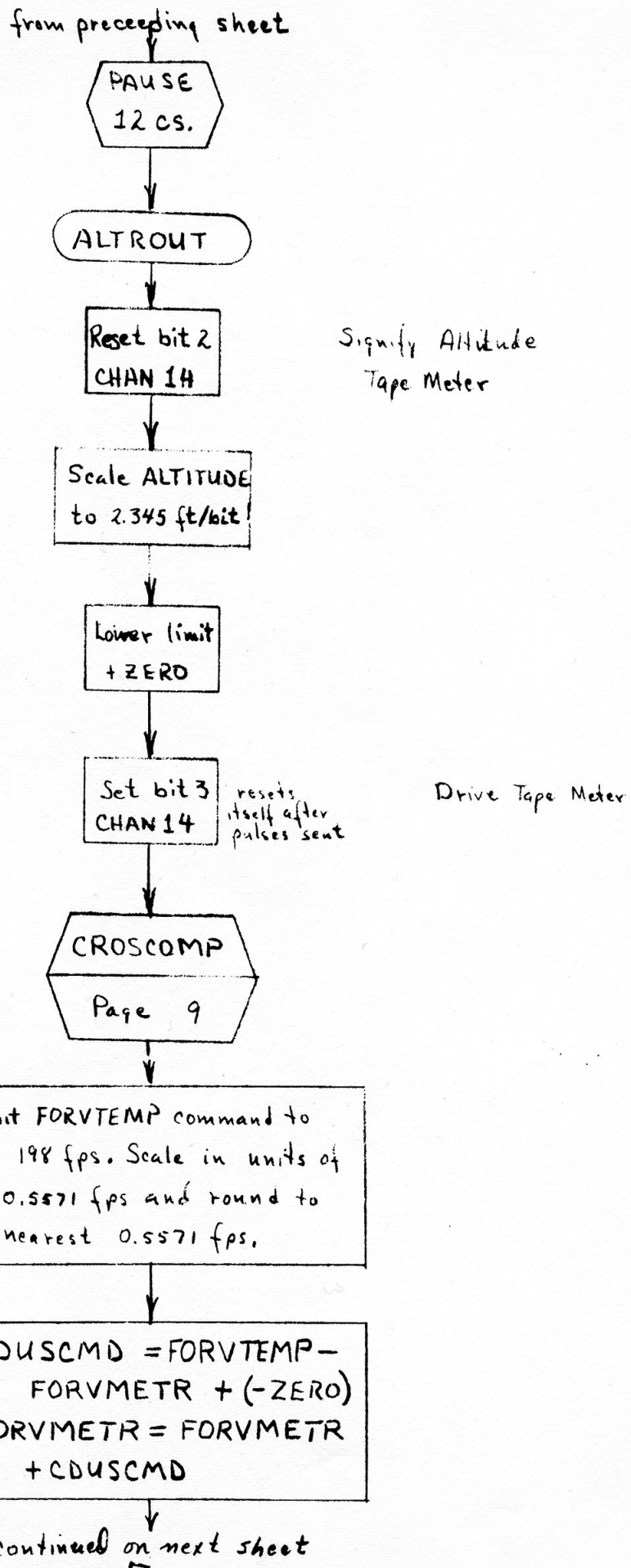
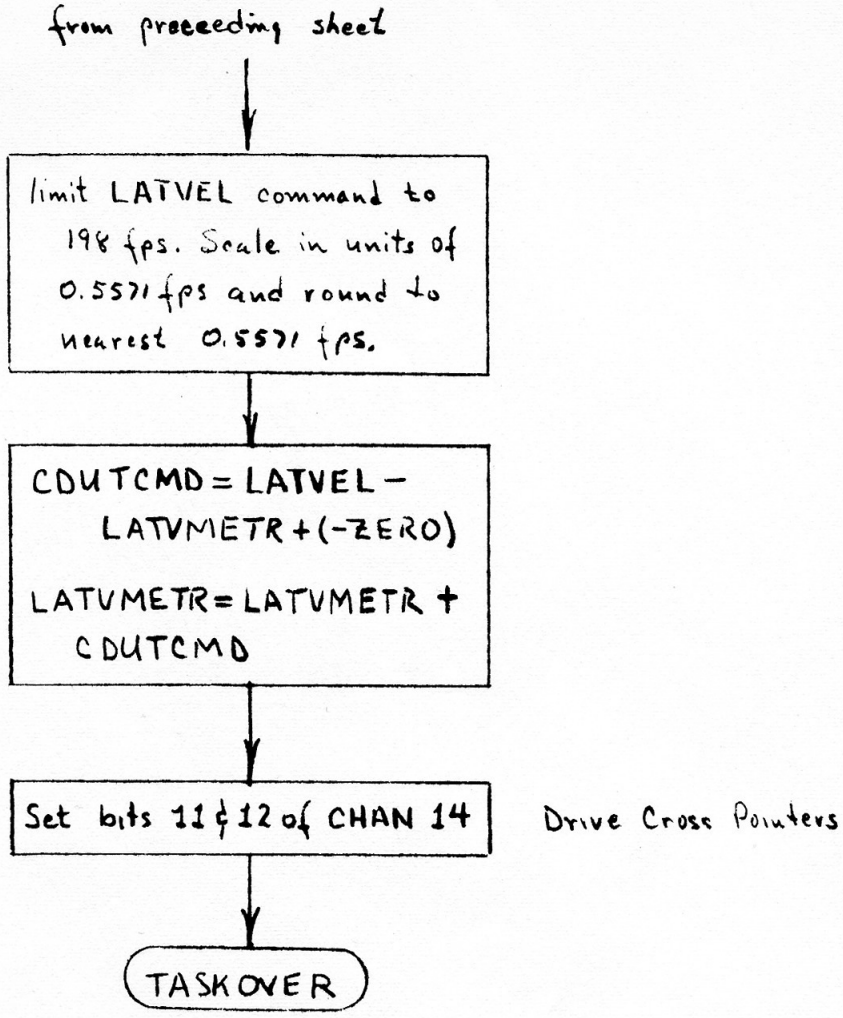
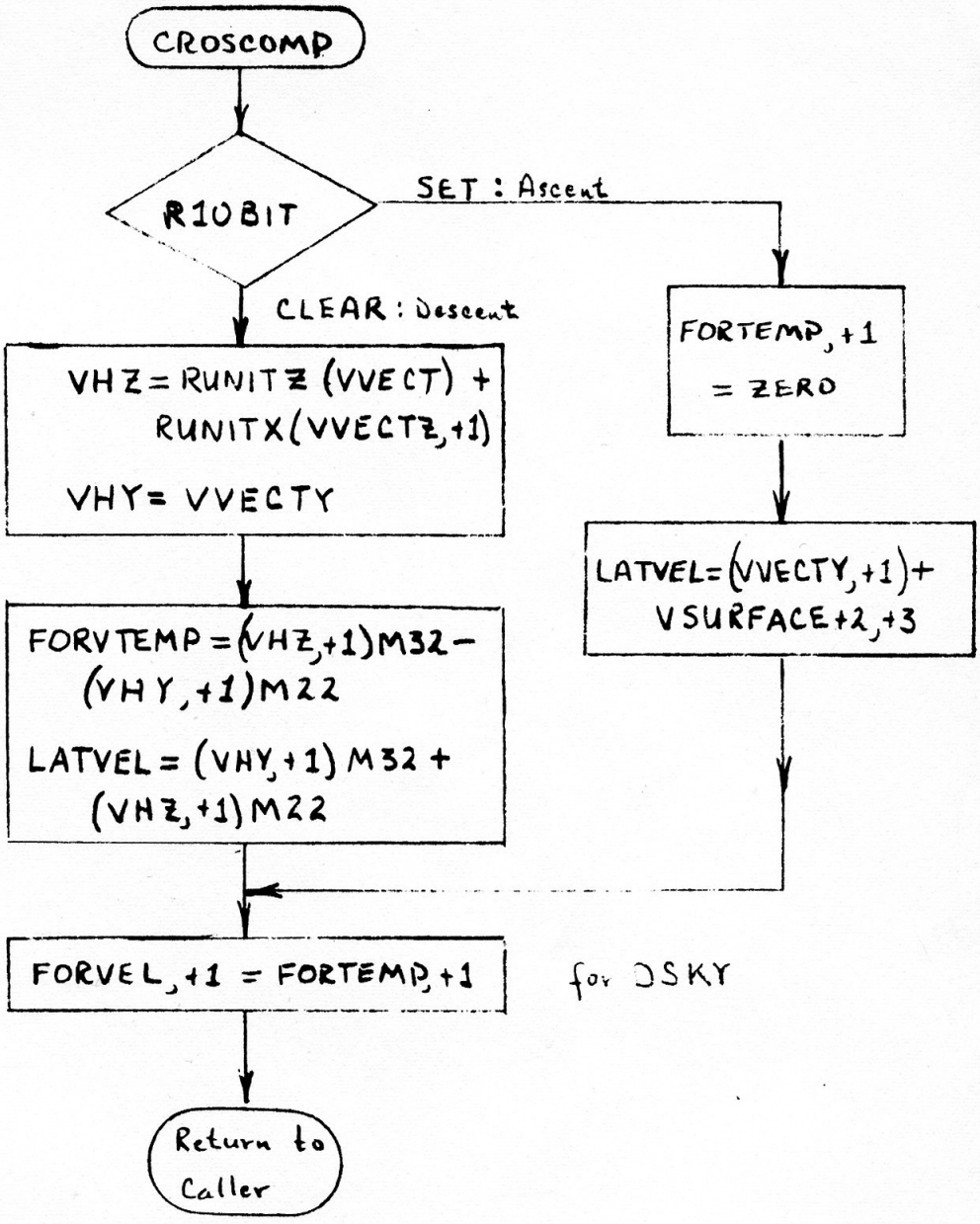
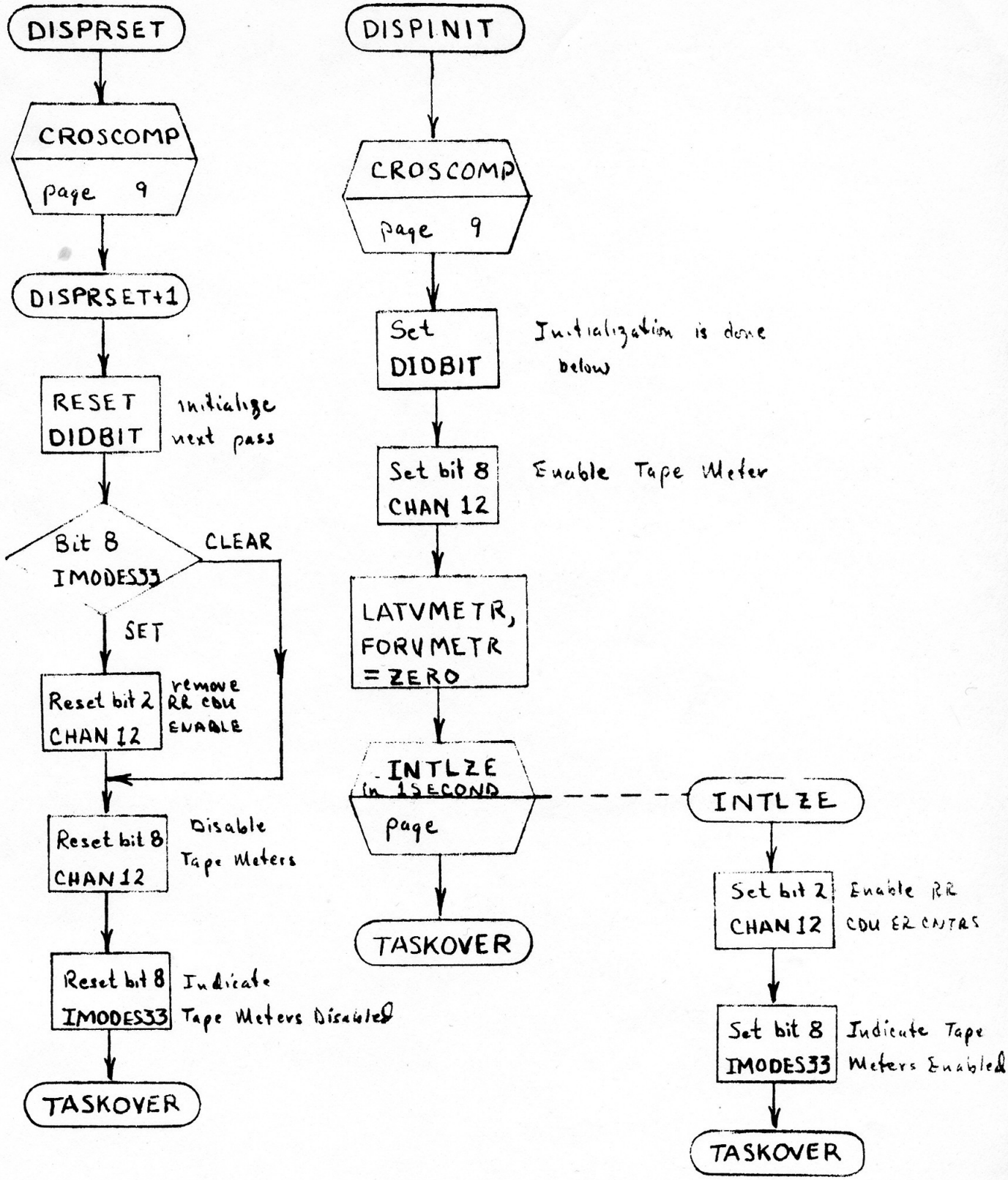

ALTSTUFF
DALTRATE = RUNIT • VVECT
ALTRATE = DALTRATE x DT
ALTITUDE = (ALTRATE + HDOTLAD) x DT + HCALCLAD
MODE SELECT
AGS, LDR
PGNCS
CLEAR
DIDBIT
DISPINIT page 10
SET : initilization already performed
RR CDU CDU ENABLE BIT
CLEAR
DISPRSET page 10
SET: Cross pointers Enabled
ALTRROUT
Set bit 2 CHAN 14
Signify Altitude-Rate Tape Meter Driven Below
Scale ALTRATE to 0.5 fps/bit & round to 0.5 fps
Set bit 3 CHAN 14
resets itself after pulses sent
Drive Tape Meter
continued on next sheet


from preceeding sheet
PAUSE 12 cs.
ALTROUT
Reset bit 2 CHAN 14
Signify Altitude Tape Meter
Scale ALTITUDE to 2.345 ft/bit
Lower limit +ZERO
Set bit 3 CHAN 14
resets itself after pulses sent
Drive Tape Meter
CROSCOMP
Page 9
limit FORVTEMP command to 198 fps. Scale in units of 0.5571 fps and round to nearest 0.5571 fps.
CDUSCMD = FORVTEMP - FORVMETR + (-ZERO)
FORVMETR = FORVMETR + CDUSCMD
continued on next sheet


from preceeding sheet
limit LATVEL command to 198 fps. Scale in units of 0.5571 fps and round to nearest 0.5571 fps.
CDUTCMD = LATVEL - LATVMETR + (-ZERO)
LATVMETR = LATVMETR + CDUTCMD
Set bits 11 & 12 of CHAN 14
Drive Cross Pointers
TASKOVER


CROSCOMP
R10BIT
SET : Ascent
CLEAR : Descent
VHZ = RUNITZ (VVECT) +
RUNITX(VVECTZ,+1)
VHY = VVECTY
FORTEMP,+1
= ZERO
LATVEL = (VVECTY,+1) +
VSURFACE+2,+3
FORVTEMP = (VHZ,+1)M32 -
(VHY,+1)M22
LATVEL = (VHY,+1) M32 +
(VHZ,+1) M22
FORVEL,+1 = FORTEMP,+1
for DSKY
Return to
Caller


DISPRSET
CROSCOMP
page 9
DISPRSET+1
RESET DIDBIT
initialize next pass
Bit 8 IMODES33
CLEAR
SET
Reset bit 2 CHAN 12
remove RR CDU ENABLE
Reset bit 8 CHAN 12
Disable Tape Meters
Reset bit 8 IMODES33
Indicate Tape Meters Disabled
TASKOVER
DISPINIT
CROSCOMP
page 9
Set DIDBIT
Initialization is done below
Set bit 8 CHAN 12
Enable Tape Meter
LATVMETR, FORVMETR = ZERO
INTLZE in 1SECOND
page
TASKOVER
INTLZE
Set bit 2 CHAN 12
Enable RR CDU ER CNTRS
Set bit 8 IMODES33
Indicate Tape Meters Enabled
TASKOVER